CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE-247667 (INDIA)

BUILDING RESEARCH NOTE

B. R. N. 25

EFFLORESCENCE IN BRICKWORK

Efflorescence and its effects

White deposits of salts are sometimes found on the surface of brickwork. These deposits, which are thin on new constructions but heavy and extensive on old ones are known as efflorescence. Such deposits may take place on exterior walls, on external renderings, on internal plastered surfaces, on exposed parapets and other similar brickwork wherever water and salt (solutions) can find way and evaporation of the solutions occurs. These are also found below the damp-proof course. These deposits are unsightly but this is a relatively minor defect. Major defects are the disintegration of brick and mortars, pushing out of the plasters and spoiling of paints and decorative treatments.

How efflorescence occurs

Water, if it finds access to brickwork, moves along its pores by capillary action and carries with it dissolved salts. As the solution evaporates from the exposed surface, the salts are left as deposits on the surface or layers just below it. Disintegration of the brick or flaking of its surface is caused by the mechanical force exerted by the salts as these crystallise just below the exposed surface. Magnesium sulphate, in particular, disintegrates bricks and pushes out plasters.

Calcium sulphoaluminate hydrate, formed by sulphate attack on cement and lime mortars is also responsible for mortar disintegration. This does not strictly fall under efflorescence but the effect produced is due to salt (sulphates) carried by water reacting with mortar.

Source of salts and water

Either some or all of the soluble salts like sulphates, carbonates, chlorides, nitrates of sodium, potassium, calcium and magnesium are found in efflorescence. These salts may originate from their presence in brick, cement concrete, plaster, mortar or earth which might have been used during construction. Underfired bricks or cement concrete contaminated with soluble salts are more prone to efflorescence. Continuous ingress of water either from top (like rain or leakage of overhead tank) or from bottom (as undergrcund low water level and water logging etc.) causes regular deposition of soluble salts on exposed surface through continuous evaporation in atmosphere. The foundation soil or loose material left over in contact with brickwork or concrete structure may also cause efflorescence.

Salts may also be produced by the action of polluted industrial atmosphere on limestone. Contamination with sea water either directly or through wind is another possible source of salt.

The source of water may be the ground water, rain striking directly on the surface of brickwork, leaky rain water pipes and water dripping from overhead tanks. Water may also find its way into the building through leaky roofs and joints at the parapet, chimney stacks or window sills. Continuous exposure to dampness and evaporation of water causes regular deposition of soluble salts present in brick, plaster, mortar or earth.

How to avoid efflorescence

(i) Any apparent source of salt, for example, a heap of contaminated earth in contact

with brickwork or chemicals thrown carelessly in chemical or fertiliser factories or photographic rooms, can be easily spotted and removed. The most practical way to avoid incidence of efflorescence is to concentrate on finding the source from which water gets access to brickwork and to eliminate it if possible.

(ii) Choice of materials :

In choosing the material to be used in construction it is better to depend on experience gained by the use of materials supplied by a particular manufacturer or from a particular locality. If, however, one has to use materials from new sources, the following simple field test may be performed to judge possible efflorescence risks.

Not less than 5 specimens of dry bricks (or masonry blocks) should be taken and each of them placed on end in a flat bottomed shallow tray. Sufficient distilled water to cover about 1.5 to 3.0 cm height of the brick should be filled in the tray. The assembly should be placed in a well ventilated warm place. After the water has been absorbed and the bricks appear to be dry the process should be repeated once again. The bricks or blocks are then examined for efflorescence. If, these do not show efflorescence, particularly on the edges, the material may be considered safe.

Any deposit formed should be chemically examined, particularly for magnesium sulphate which causes maximum disintegration of bricks. Bricks with magnesium sulphate content higher than 0.05% should not be used in construction. Soluble salt content in sands (chloride and sulphate together) should not exceed 0.1%. Some general guidelines for selection of various materials are given below :

(a) Bricks :

Well fired bricks should be used in construction particularly in exposed parts. Such bricks usually have high strength, low water absorption and low salt content. Bricks with black core (where salts concentrate) or with lime nodules (which cause lime bursting) should be avoided. Soluble salts get evaporated at higher temperature of firing giving low porosity and higher strength.

(b) Mortars :

Portland cement used in mortars contains tricalcium aluminate. Sulphates added at the time of manufacture of cement or from bricks or ground may be carried to the mortars by water, where calcium sulphoaluminate hydrate is formed. This compound has a large specific volume. Hence expansion occurs and the mortars disintegrate. The damage caused depends on the amount and the nature of sulphates present. More soluble sulphates of sodium, potassium and magnesium produce greater damage than relatively less soluble calcium sulphates.

Mortars used should, therefore, be sulphate resistant and should prevent rain penetration. Use of very rich mortars should be discouraged. Plasticised mortar mixes (aerated mortars) offering higher resistance to rain penetration also offer higher resistance to movement of soluble salts. But use of such mortars has not yet commenced in India.

1 : 1 : 6 cement : lime : sand mix is suitable for external walls. Care should be taken that sand itself is not a source of salts. For internal use 1:2:9 mix may be used. For use below damp proof course 2 : 1 : 9 cement : lime : sand or 1 : 3 cement : sand should be used With high strength engineering bricks 1 : 3 cement : sand mortars or resin mortars are preferable.

(c) Plastering :

Due importance should be given to the choice of materials, particularly sand. It should be carefully chosen and tested for its salt content. Obviously, sands from sea side or river estuaries should be avoided.

Mixes suitable for external plastering on clay bricks and blocks are :

(1) 1 : 1 : 6 (cement : lime : sand) for undercoat

(2) 1:1:6 or 1 : 2 : 9 (cement : lime : sand) for finish.

As with mortars, use of very rich mixes to

improve rain penetration resistance of plaster is to be discouraged. With very rich mixes, surface of plaster cracks due to shrinkage. Water gets in through these cracks and is trapped. The locked-in water becomes a medium for sulphate attack.

Where definite possibility of migration of sulphate from the background, either from bricks or soil (inadequate DPC) exists, it is advisable to use sulphate resisting cement for renderings. It is convenient to use same type of cement in mortars and in renderings for masonry.

For internal plastering o' brick and block surfaces, 1:6 cement : sand mix with plasticisers or mixes used for exterior plasters may be used. Rich mixes should again be avoided.

(d) Stone :

Sometimes brick is used in conjunction with stone. Limestone reacts with sulphurous atmosphere producing calcium sulphate which may affect the masonry and may also be leached out as efflorescence. Hence limestone and bricks should not be used together. Use of sandstone with limestone should also be avoided as calcium sulphate from limestone may be carried to sandstone by water. Calcium sulphate flakes off sandstone surface

If porous stone is used in sea side buildings their surface get eroded. It is best to use granite or basalts under such situations. Porous stones should not be used near ground level for obvious reasons. Exterior mortar joints should be properly pointed.

(iii) Construction methods :

It is essential to prevent water getting access to brickwork. Details of steps to be taken to prevent water getting into buildings are given in Building Digest No. 34—"Dampness in buildings." A few general points of precautions are that water used in construction should be free from salt and the bricks should be soaked to a minimum. Overburnt bricks should be used below D. P. C. level. Such bricks have high strength, low water absorption and are practically free from salt. Bricks of compressive strength less than 175 kg/cm^2 should not be used in the exposed parts of a building. Under fired, low strength bricks should also not be used in combination with limestone.

Two coats of bitumen cutback comprising hot bitumen five parts and Kerosene Oil 1 part by weight should be applied on both the sides of foundation walls upto D.P.C. level. This checks continuous rise of underground moisture.

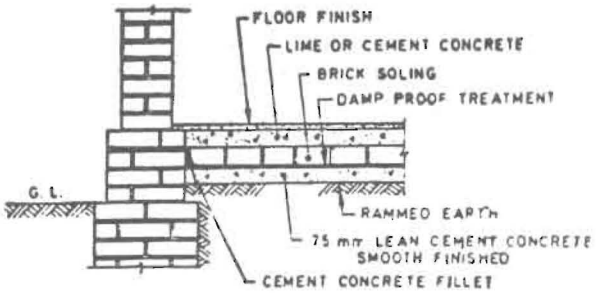

Fig. 1 Damp-proof Treatment Above Ground Level for New Building.

It may be necessary to replace D. P. C. or new D.P.C. may have to be provided in buildings where it was not provided originally.

When a horizontal damp-proofing treatment has to be carried over to a vertical face, a cement morter (1:4) fillet 75 mm. in radius shall be provided at the Junction. Both the horizontal and vertical surfaces shall be finished smooth. For residential buildings, a cement mortar (1:4) or 1:2:4 Concrete 12 mm. thick with water proofing compound (I.S. 2645-1975) added may be laid below the course of brick.

While applying rendering on a wall the surface should be cleaned. Joints should be raked out and cleaned and the whole surface should be wetted so as to avoid excessive suction of water from the finishing coat. Heavy trowelling and skimming of the surface should be avoided as these lead to greater incidence of efflorescence.

Sealing coats are sometimes applied on plastered surfaces before giving a decorative finish. Such coats postpone efflorescence in early stages but lead to serious difficulties later. They should, therefore, be avoided. Plasters should be allowed to dry adequately before applying decorative finish.

Integral water proofers should not be depended upon to prevent efflorescence. They do not act as vapour barriers and cannot withstand flow of water with even a small pressure head.

Remedies

There is no perfect & universal remedy for efflorescence except complete isolation of the construction from water. This is however, not always practical. Depending upon the site conditions and available materials a judicious precaution must be undertaken by construction engineers. Some of the remedial measures in use, in particular circumstances, are given below :

(i) Efflorescence on brickwork traceable to salts in the materials can be removed by dry brushing and washing repeatedly. Patches of salt on isolated bricks in buildings provided with adequate D. P. C. may be removed like wise. Intensity of efflorescence diminishes after each washing.

(ii) Water penetration in stone construction may be checked by using water repellent surface treatments such as silicone treatment. It is scuccessful if the surface is free from cracks or fissures. Similar treatment can also be given to brickwork.

(iii) Efflorescence in new buildings, with adequate D. P. C. is not very serious and it usually disappears with rain and wind. If it does not, the method given in (i) may be used. Such efflorescence may reappear in dry season but is usually less in intensity. Finally it disappears as the salt content of the bricks is gradually leached out.

(iv) Efflorescence in old buildings, internal or external, is a potential danger to such buildings. The cause can be traced to the ingress of water into the building. Usually the D.P.C. is at fault or it has not been provided at all. This has to be properly rectified. Accumulation of water close to walls should be prevented by providing plinth protection. Other possible sources of water - ingress should be carefully checked and rectified. Continuous wetting and drying of walls causes regular dissolution of soluble salts present either in brick, concrete or plaster. These soluble salts get deposited over surface or weaken the plaster after drying. If source of water is contaminated with soluble salts it also causes the same effect. Hence continuous wetting & drying should be checked as soon as possible.

Internal efflorescence in old buildings sometimes pushes out the plaster leaving the brickwork bare. Such surface should be given a heavy coat of a bitumen based material (cold sticker) and the surface should be rendered with gypsum plaster.

If plasters have not been pushed out, dry lining of the internal surface may be done to camouflage the efflorescence. This step obviously, is not a remedy. Similarly, where remedial measures given above fail to check heavy efflorescence on the exterior of walls in old buildings, the following measures may be used to camouflage the ugly appearance. Plasters and mortar joints should be scrapped off. Precast plastering on expanded metal which has been coated with bitumen should be fixed (in a manner as to be removable when required) with the help of battens on the wall leaving a small air gap between the background and the plaster. When a large quantity of salt accumulates, the plaster should be removed, the background properly cleaned and the plaster replaced.

(v) *Buildings near the sea :* The problem in these buildings is two fold : efflorescence and erosion. If the building is provided with adequate D. P. C., measures to combat erosion should be adequate to prevent efflorescence. One way to prevent erosion is to provide the external and internal surfaces with an adequate coat of bitumen based material and dry lining fixed on it. The dry lining protects the building while it may itself erode out. When the lining erodes, it can be replaced by new one.

Replastering of the eroded wall surface with rich mix has been found inadequate.

(vi) Electro-osmosis and latex-silicone injection treatments are claimed to have prevented elflorescence in existing building without D. P. C. Both the methods aim at

damp-proofing the walls and both need handling by specialists.

Electro - osmotic damp - proofing depends upon discharging the electrically charged state of the wall characteristic of capillary moisture movement in porous builiding materials. Special low conductivity circuit is embedded in the wall and is earthed at regular intervals so as to discharge the walls.

In latex silicone injection, rubber latex and sodium siliconate are mixed in the ratio 2:1 and injected at regular intervals into the mortar bed of the wall. These provide damp-proofing mainly by blocking the pores.

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